CLAIMS

What is claimed is:

1. A method of operating a camless engine valve actuation system in an internal combustion engine, the system including one or more actuators controlled by a controller operating under program control to control an engine valve, comprising:

determining a safe trajectory for the engine valve versus crankshaft angle, the safe trajectory separating acceptable trajectories from unacceptable trajectories risking or causing collision of the engine valve another engine valve or with the engine piston;

determining the desired trajectory for the engine valve versus crank angle;

controlling the actuators to nominally cause the engine valve to follow the desired trajectory;

sensing the actual engine valve trajectory, and if the actual engine valve trajectory deviates into an unacceptable trajectory, controlling the actuators to close the engine valve.

2. The method of claim 1 further comprising, if the actual engine valve trajectory deviates from the desired trajectory more than an allowable deviation within the

acceptable trajectories, controlling to actuators to reduce the deviation.

3. The method of claim 1 wherein the desired trajectory for the engine valve versus crank angle is determined as a desired opening angle, a desired opening flank rate, a desired lift, a desired closing flank rate and a desired closing angle.

4. The method of claim 1 wherein the control of the actuators to nominally cause the engine valve to follow the desired trajectory is based in part on previous actuator controls and associated engine valve responses.

5. The method of claim 1 wherein the safe trajectory for an intake valve is comprised of a minimum opening angle and a maximum allowable opening flank rate.

6. The method of claim 1 wherein the safe trajectory for an exhaust valve is comprised of a maximum allowable closing angle and a minimum allowable closing flank rate.

7. The method of claim 1 wherein the safe trajectory for an exhaust valve is comprised of a minimum allowable opening angle and a maximum allowable opening flank rate.

8. The method of claim 1 wherein a safe trajectory is determined based on engine operating conditions and environmental conditions.

9. The method of claim 8 wherein a safe trajectory is determined based on past, current and commanded engine load.

10. The method of claim 1 wherein a desired trajectory is determined based on engine operating conditions and environmental conditions.

11. The method of claim 10 wherein a desired trajectory is determined based on past, current and commanded engine load.

12. The method of claim 10 wherein the desired trajectory for the engine valve is determined, at least in part, from equations.

13. The method of claim 10 wherein the desired trajectory for the engine valve is determined, at least in part, from lookup tables.

14. The method of claim 1 wherein the safe trajectory for the engine valve is determined, at least in part, from equations.

15. The method of claim 1 wherein the safe trajectory for the engine valve is determined, at least in part, from lookup tables.

16. The method of claim 1 wherein the actuators comprise a hydraulic actuator controlled by electronically controlled valving.

17. The method of claim 16 wherein the hydraulic actuator is a single stage hydraulic actuator.

18. The method of claim 17 wherein the hydraulic actuator is a two stage hydraulic actuator.

19. The method of claim 18 wherein a first stage comprises electromagnetically actuated spool valving, and the second state comprises hydraulically controlled spool valving.

20. A method of operating a camless engine valve actuation system in an internal combustion engine, the system including one or more actuators controlled by a controller operating under program control to control an engine valve, comprising:

determining a safe trajectory for the engine valve versus crankshaft angle, the safe trajectory separating

acceptable trajectories from unacceptable trajectories risking or causing collision of the engine valve with another engine valve or with the engine piston;

determining the desired trajectory for the engine valve versus crank angle;

controlling the actuators to nominally cause the engine valve to follow the desired trajectory;

sensing the actual engine valve trajectory, and;

if the actual engine valve trajectory deviates from the desired trajectory by more than an allowable deviation, controlling to actuators to reduce the deviation;

if the actual engine valve trajectory deviates from the desired trajectory into an unacceptable trajectory, controlling the actuators to close the engine valve.

21. The method of claim 20 wherein the desired trajectory for the engine valve versus crank angle is determined as a desired opening angle, a desired opening flank rate, a desired lift, a desired closing flank rate and a desired closing angle.

22. The method of claim 20 wherein the control of the actuators to nominally cause the engine valve to follow the desired trajectory is based in part on previous actuator controls and associated engine valve responses.

23. The method of claim 20 wherein the safe trajectory for an intake valve is comprised of a minimum opening angle and a maximum allowable opening flank rate.

24. The method of claim 20 wherein the safe trajectory for an exhaust valve is comprised of a maximum allowable closing angle and a minimum allowable closing flank rate.

25. The method of claim 20 wherein the safe trajectory for an exhaust valve is comprised of a minimum allowable opening angle and a maximum allowable opening flank rate.

26. The method of claim 20 wherein a safe trajectory is determined based on engine operating conditions and environmental conditions.

27. The method of claim 26 wherein a safe trajectory is determined based on past, current and commanded engine load.

28. The method of claim 20 wherein a desired trajectory is determined based on engine operating conditions and environmental conditions.

29. The method of claim 28 wherein a desired trajectory is determined based on past, current and commanded engine load.

30. The method of claim 28 wherein the desired trajectory for the engine valve is determined, at least in part, from equations.

31. The method of claim 28 wherein the desired trajectory for the engine valve is determined, at least in part, from lookup tables.

32. The method of claim 20 wherein the safe trajectory for the engine valve is determined, at least in part, from equations.

33. The method of claim 20 wherein the safe trajectory for the engine valve is determined, at least in part, from lookup tables.

34. The method of claim 20 wherein the actuators comprise a hydraulic actuator controlled by electronically controlled valving.

35. The method of claim 34 wherein the hydraulic actuator is a two stage hydraulic actuator.

36. The method of claim 35 wherein a first stage comprises electromagnetically actuated spool valving, and the second state comprises hydraulically controlled spool valving.